**FOR UN SUB GROUP GRSP – JUNE 2022**

# NEXT GENERATION ATDs

REPRESENTING HUMANS OF ALL SIZES, AGES, AND GENDERS

HUMANETICS


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# CURRENT & NEXT GENERATION ATDS

Crash test dummy technology has evolved to become the next generation of ATDs that can better replicate a person's physiology. These dummies are instrumented to measure INJURY risks for each different occupant, with more sensors in the legs, abdomen and pelvis, more facial sensors, improved neck, chest and shoulder biofidelity, and more ways to measure chest impact to reduce the risk of rib fractures. Data provided by advanced dummies enables engineers to design for safer and more effective seat belts, headrests, air bags, pedals and cabin structures.

**Next Generation ATDs.**

- THOR-50M
- THOR-5F
- THOR-AV 50M
- THOR-AV-5F
- WorldSID-50M
- WorldSID-5F
- Elderly Female
- Obese Male
- BioRID
- Q-Dummy Children
- Legform Impactors

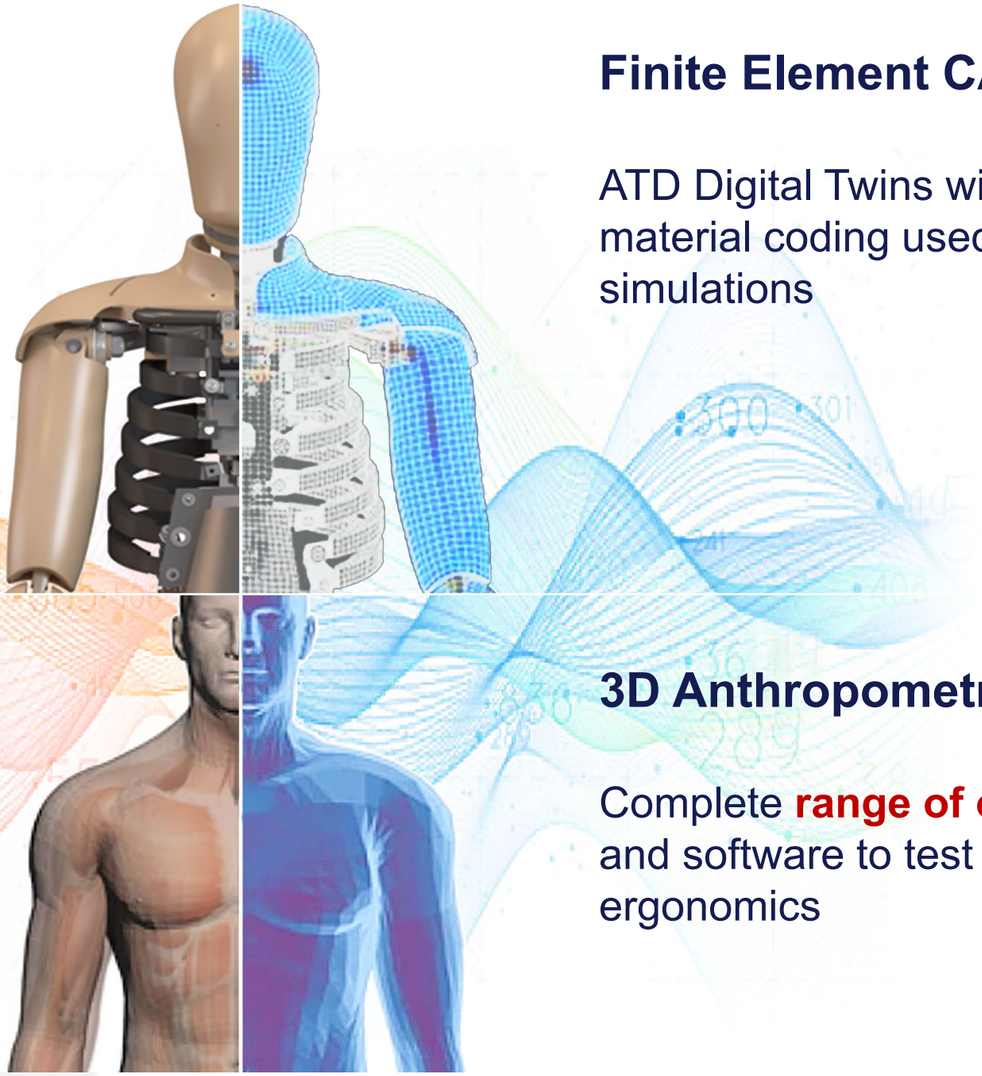
# INTEGRATION OF PHYSICAL AND SIMULATION

## Anthropomorphic Test Devices

Sophisticated biofidelic test device with 150 channels of sensory intelligence

## Finite Element CAE Models

ATD Digital Twins with precision material coding used in crash test simulations



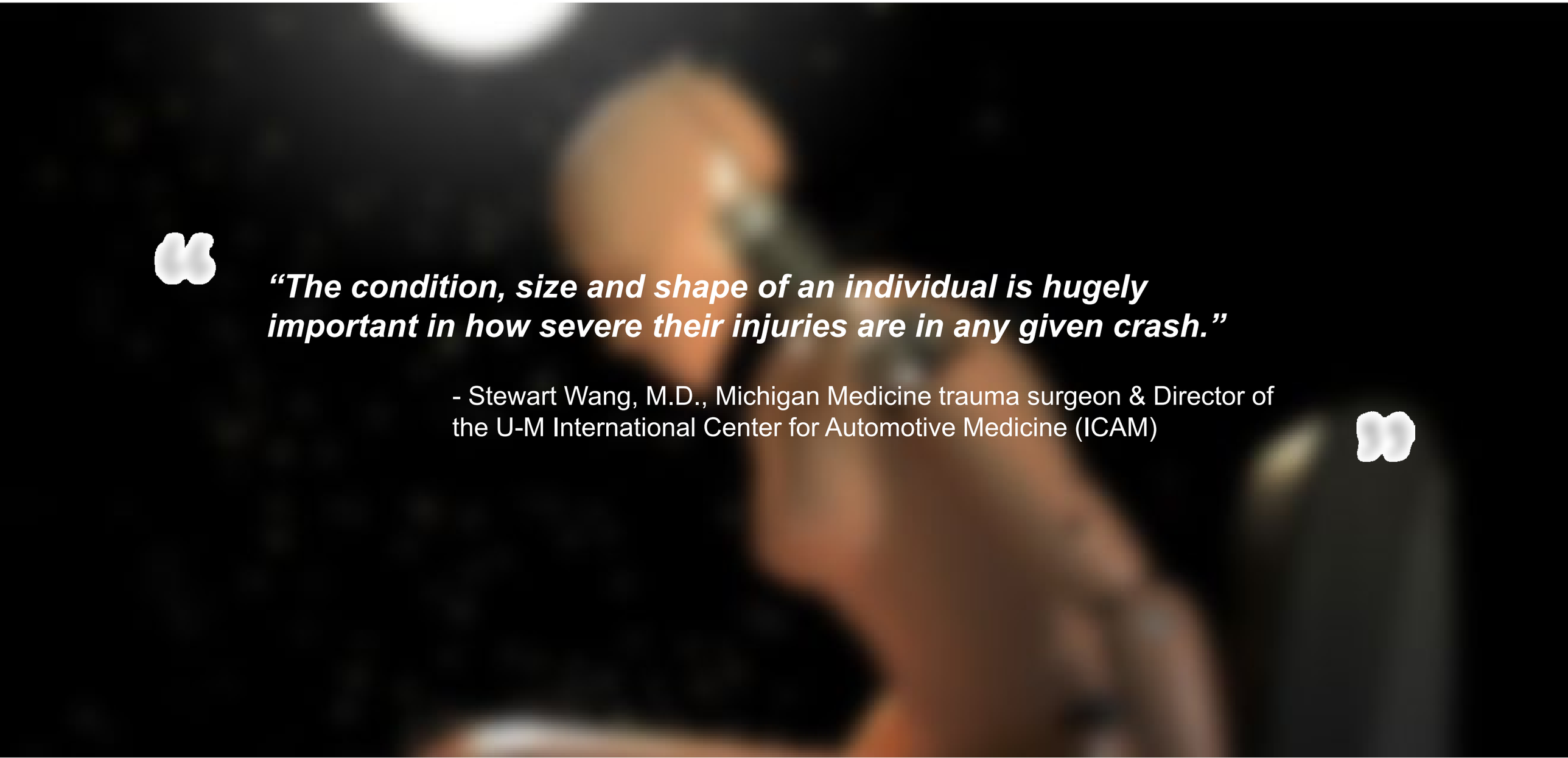
## Human Body Models

Finite Element models of Human bodies of **different sizes and shapes** used in selected injury simulation

## 3D Anthropometric Avatars

Complete **range of occupant sizes** and software to test kinematics and ergonomics

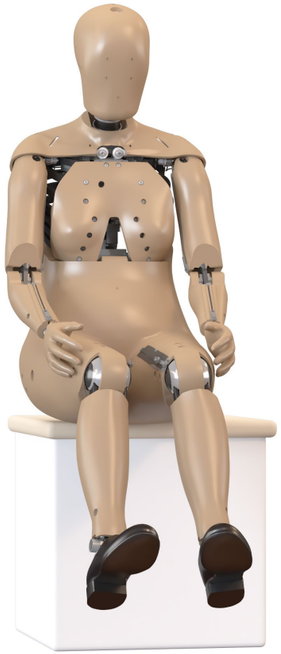
# PROTECTING VULNERABLE OCCUPANTS



***“The condition, size and shape of an individual is hugely important in how severe their injuries are in any given crash.”***

- Stewart Wang, M.D., Michigan Medicine trauma surgeon & Director of the U-M International Center for Automotive Medicine (ICAM)

# RESEARCH IS ALIGNED ON THE INCREASED VULNERABILITY & DIFFERENT INJURIES FOR WOMEN



## A 2019 University of Virginia study (J. Forman, et al):

Newer model year vehicle (2009+) have less risk to occupants than older models.
Females are at greater risk of AIS2+ and AIS3+ injuries.
Improvements in thorax injury risk lags behind the progress in other injury areas. made

*Source: Jason Forman, Gerald S. Poplin, C. Greg Shaw, Timothy L. McMurry, Kristin Schmidt, Joseph Ash & Cecilia Sunnevang (2019) Automobile injury trends in the contemporary fleet: Belted occupants in frontal collisions, Traffic Injury Prevention,*

## 2021 IIHS study (M. Brumbelow, J. Jermakian)

Females are at greater overall risk of injury AIS2+ and AIS3+ injuries, after normalizing for some occupant and crash factors.
When additional factors are considered such as crash configurations and vehicle mass are taken into account, the increased risk to females is reduced:
Females remain at greater risk of lower extremity injury & AIS2 injuries
Females and males are at similar risk for AIS3 injury (excluding lower extremity)
Females and males have both benefited from recent safety regulations and protocols

*Source*: Matthew L Brumbelow, Jessica S. Jermakian (2021) Injury risks and crash worthiness benefits for females and males: Which differences are physiological?

## International Center for Automotive Medicine (S. Wang) , University of Michigan)

Studied the effects of occupant parameters on injury risk using an extensive data base of motor vehicle crash evaluations.

In dangerous crashes, occupant factors are as significant as crash configuration and more important than crash severity and belt use in predicting who will be seriously injured.

Real life crash occupant anthropometry and body composition (Morphomics) can be derived from medical imaging data and is useful for safety system design, tuning and evaluations.

Field data suggests females are at greater risk of lower leg injuries.

*Source: 2021 ICAM presentation to Humanetics*

# WOMEN ARE MORE VULNERABLE TO INJURY & TO DIFFERENT INJURIES

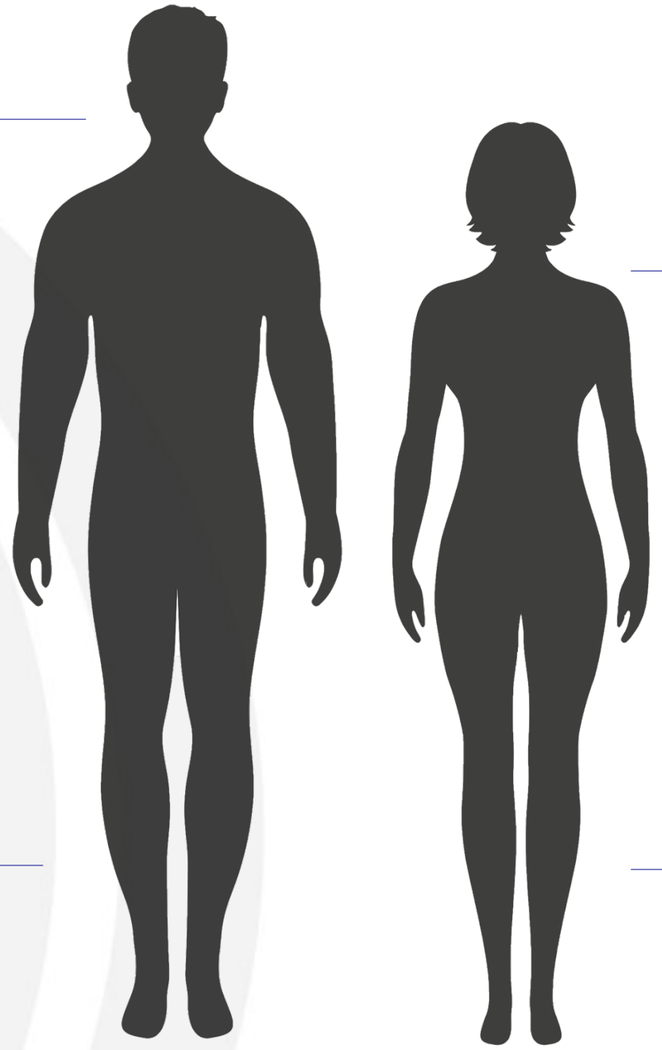
Women and men have different bone density, muscle structure, fat distribution and seating positions.

Different support from the head rest

Different arm position

Women sit closer to the steering wheel & sterring column

Different leg position



Women are 17% more likely to die and 73% more likely to be injured in a crash in a frontal crash.

**24%** higher risk of WAD symptoms lasting longer than one month

**58.2%**[1] higher risk of moderate arm injuries

**38.5%**[2] higher risk of moderate abdomen injuries

**79%** higher risk of suffering serious leg injuries

[1] ±20.6% | [2] ±28.4%

Source: NHTSA Injury Vulnerability & Effectiveness of Occupant Protection Technologies for Older Occupants & Women
UMTRI | Kullgren et al [2020] | IIHS [2021] | NHTSA [2013]



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# CURRENT ADULT ATDS IN REGULATION / CONSUMER METRIC (NCAP & IIHS)

| | SIDE IMPACT | | | | | FRONTAL IMPACT | | | | | REAR |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Regulation** | **SID-IIs** | **WSID-5F** | **WSID-50M** | **ES2** | **ES2-re** | **THOR-5F** | **THOR-50M** | **Hybrid III-5F** | **Hybrid III-50M** | **Hybrid III 95M** | **BioRID II** |
| FMVSS 208 | | | | | | | | | | | |
| FMVSS 214 | | | | | | | | | | | |
| US NCAP | | | | | | | | | | | |
| IIHS | | | | | | | | 2023 Rear | | | |
| Euro NCAP | | | | | | 2027 | | | | | |
| UN R17 | | | | | | | | | | | |
| UN R94 | | | | | | | | | | | |
| UN R95 | | | | | | | | | | | |
| UN R135 | | | | | | | | | | | |
| UN R137 | | | | | | | | | | | |
| Japan Regs | | | | | | | | | | | |
| JNCAP | | | | | | | 2024 | | | | |
| China Regs | | | | | | | | | | | |
| C-NCAP | | | | | | | | | | | |
| KNCAP | | | | | | | 2023 | | | | |
| Latin NCAP | | | | | | | | | | | |
| ANCAP | | | | | | | | | | | |




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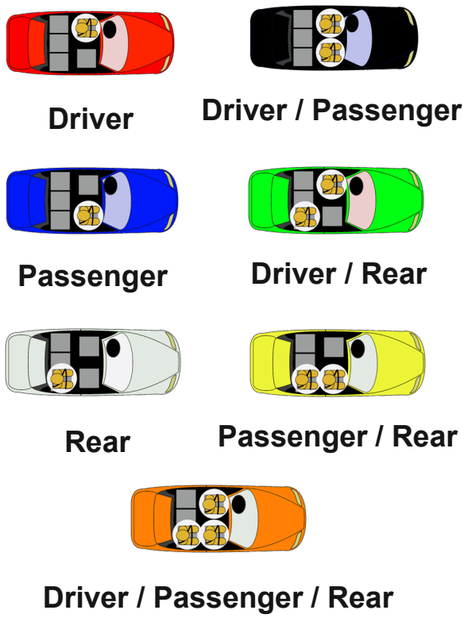
# FEMALE ATDS IN REGULATION / CONSUMER METRIC

| Regulation | SID-IIs | WSID-5F | | THOR-5F | Hybrid III-5F | Elderly | THOR-AV-5F | EvaRID |
|---|---|---|---|---|---|---|---|---|
| FMVSS 208 | | | | | | | | |
| FMVSS 214 | | | | | | | | |
| US NCAP | | | | | | | | |
| IIHS | | | | | 2023 | | | |
| Euro NCAP | | | | 2027 | | | | |
| UN R137 | | | | | | | | |
| Japan Regs | | | | | | | | |
| JNCAP | | | | | | | | |
| C-NCAP | | | | | | | | |
| KNCAP | | | | | | | | |
| ANCAP | | | | | | | | |



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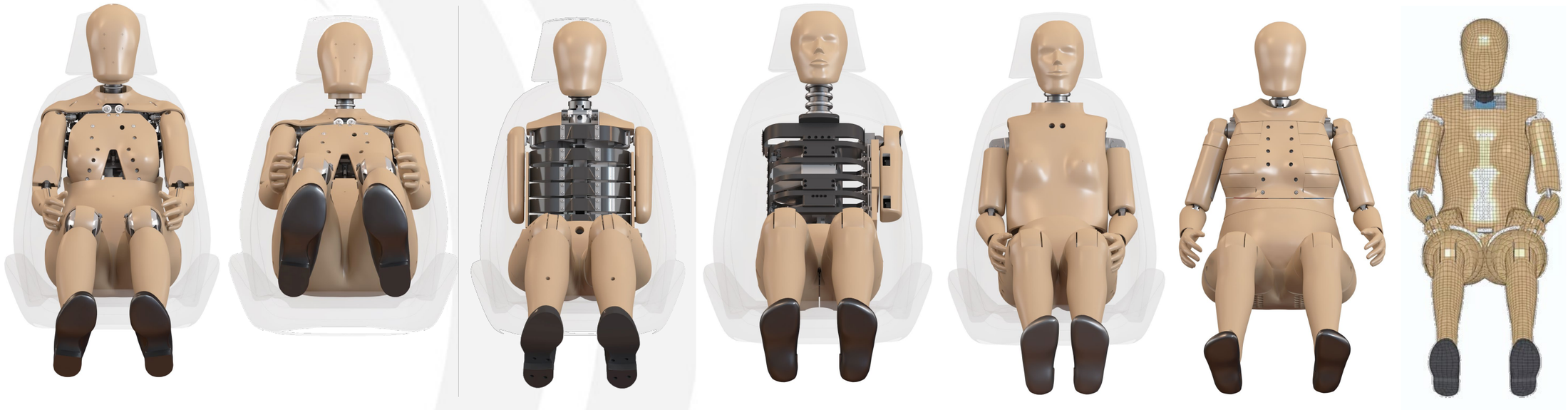
# FEMALE ATDS

Female ATDs are important tools to measure injury risks for women drivers and passengers that reflect size and geometry of smaller adult occupants.

Our lineup of Next Generation ATDs.

- THOR-5F
- THOR-AV-5F
- WorldSID-5F
- SID-IIs
- Hybrid III 5th
- Elderly Female
- EvaRID





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# THOR5F DEVELOPMENT

- THOR incorporates **advancements in biomechanical and injury prediction capabilities** that were unavailable to the Hybrid III designers in the 1970's, providing a more humanlike response to impact loading

- The THOR-5F includes anatomically correct designs in the **neck, chest, shoulder, spine, and pelvis based** on the AMVO study to represent the human occupant response in a full-frontal or frontal offset oblique vehicle crash environments

- Key improvements **include over 150+ channels available for injury sensing** to help drive design countermeasures that ensure more survivable crash conditions

| | | |
|---|---|---|
| TOTAL WEIGHT | 47.3 kg | 104.3 lb |
| SEATED HEIGHT | 788.1 mm | 31 in |



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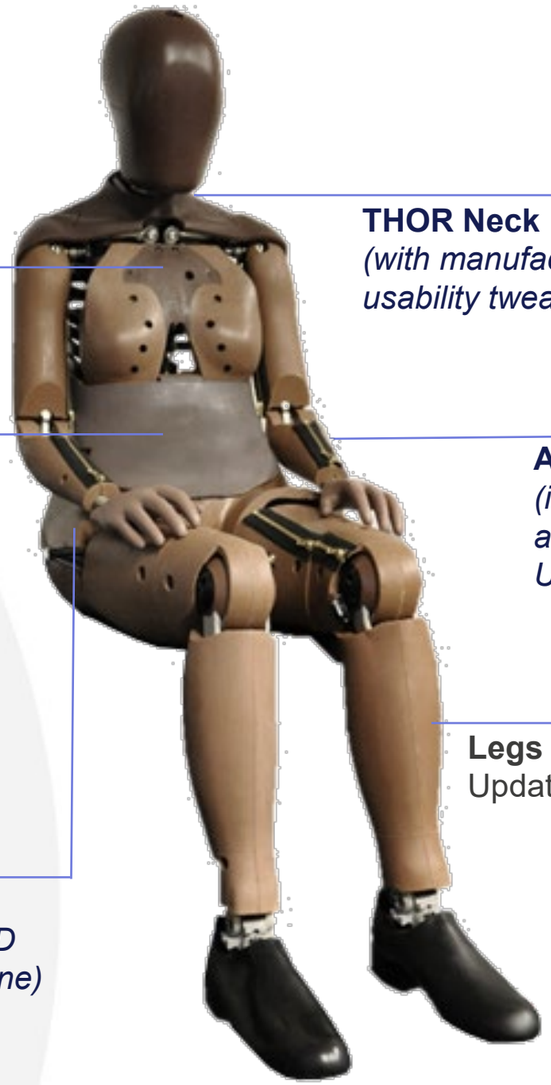
# SOME OF THE THOR-5F ADVANCED FEATURES:

**APTS Sensors**
*(replaces IR-TRACCs in abdomen)*

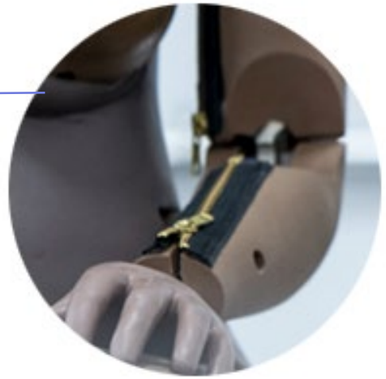
**Abdomen**
*(molded instead of canvas)*

**Breast and Sternum**
integrated together



**THOR Neck**
*(with manufacturing and usability tweaks)*

**Arms**
*(instrumented, elbow joint and flesh comply with UMTRI AMVO 5F)*



**Legs**
Updated Design

**Pelvic Bone**
*(complies with 3D human pelvic bone)*

The THOR-5F is DAS-ready (on-board Data Acquisition System) with 150-channel capabilities



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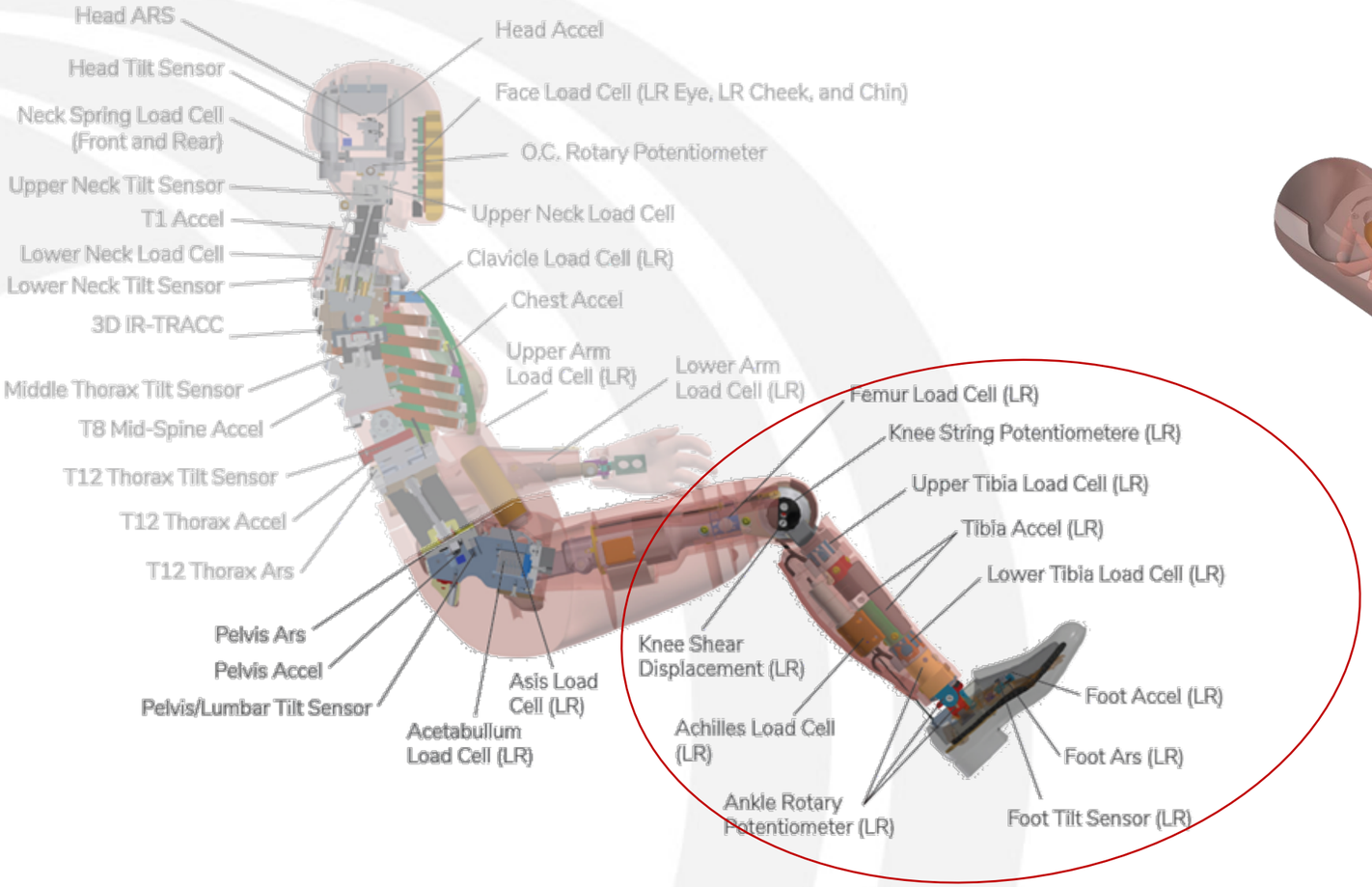
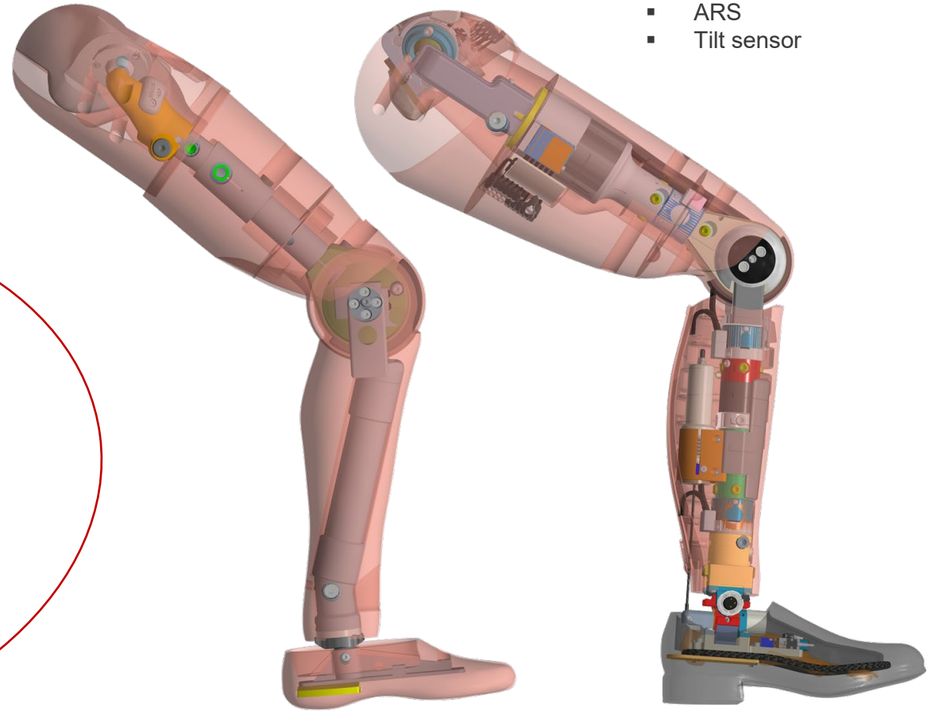
# THOR-5F LEG SENSORS




## Leg Sensors

- Femur load cell
- Upper tibia load cell
- Lower tibia load cell
- Achilles load cell
- Knee string potentiometer
- Three ankle rotary potentiometer
- Tibia accelerometer
- Foot accelerometers
- ARS
- Tilt sensor



Hybrid-III THOR-5F



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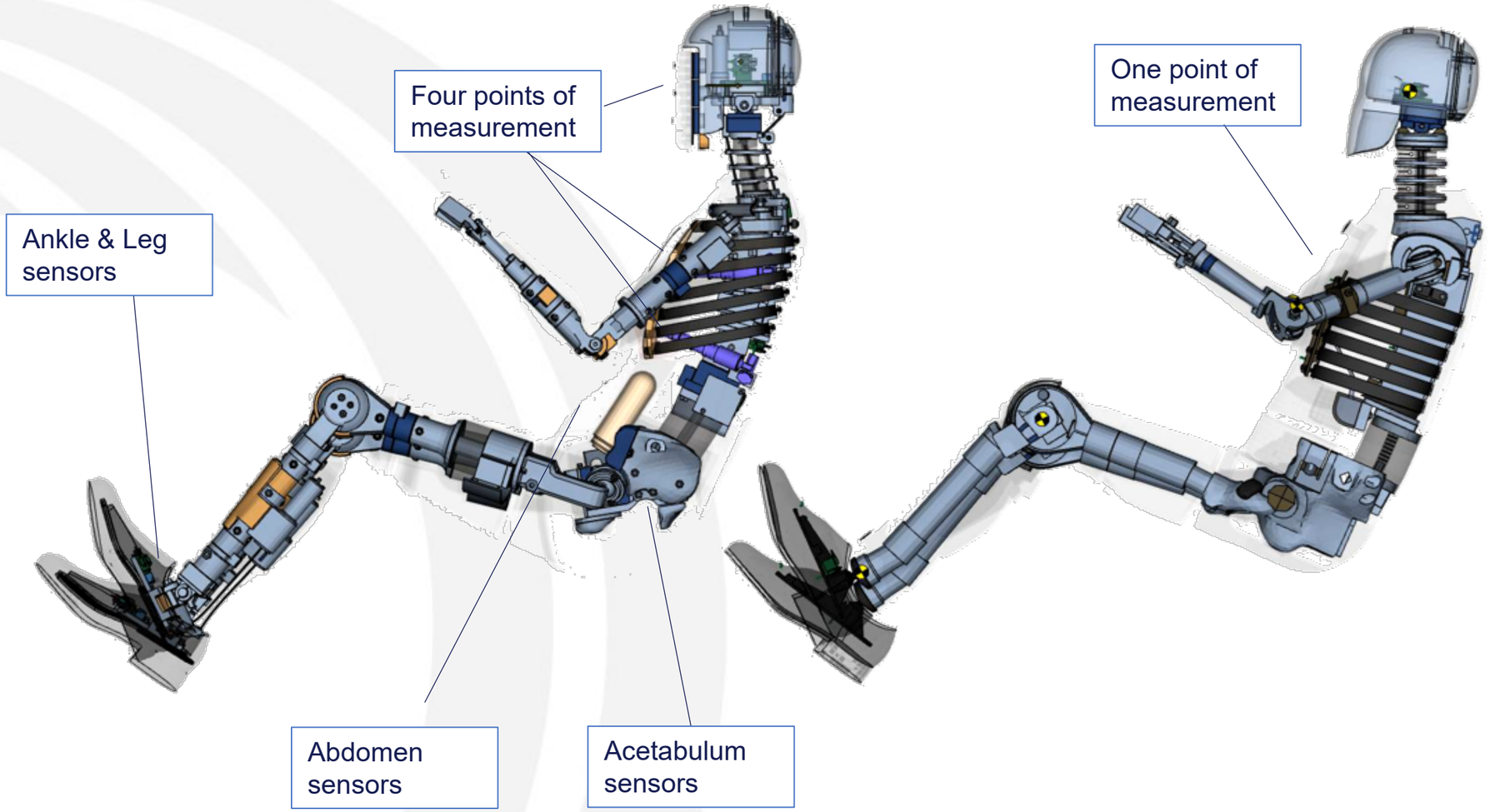
# THOR-5F vs. HYBRID III 5F

THOR 5F is designed around female physiology (pelvis, ribs, chest, neck) and instrumented when women are vulnerable to injury.



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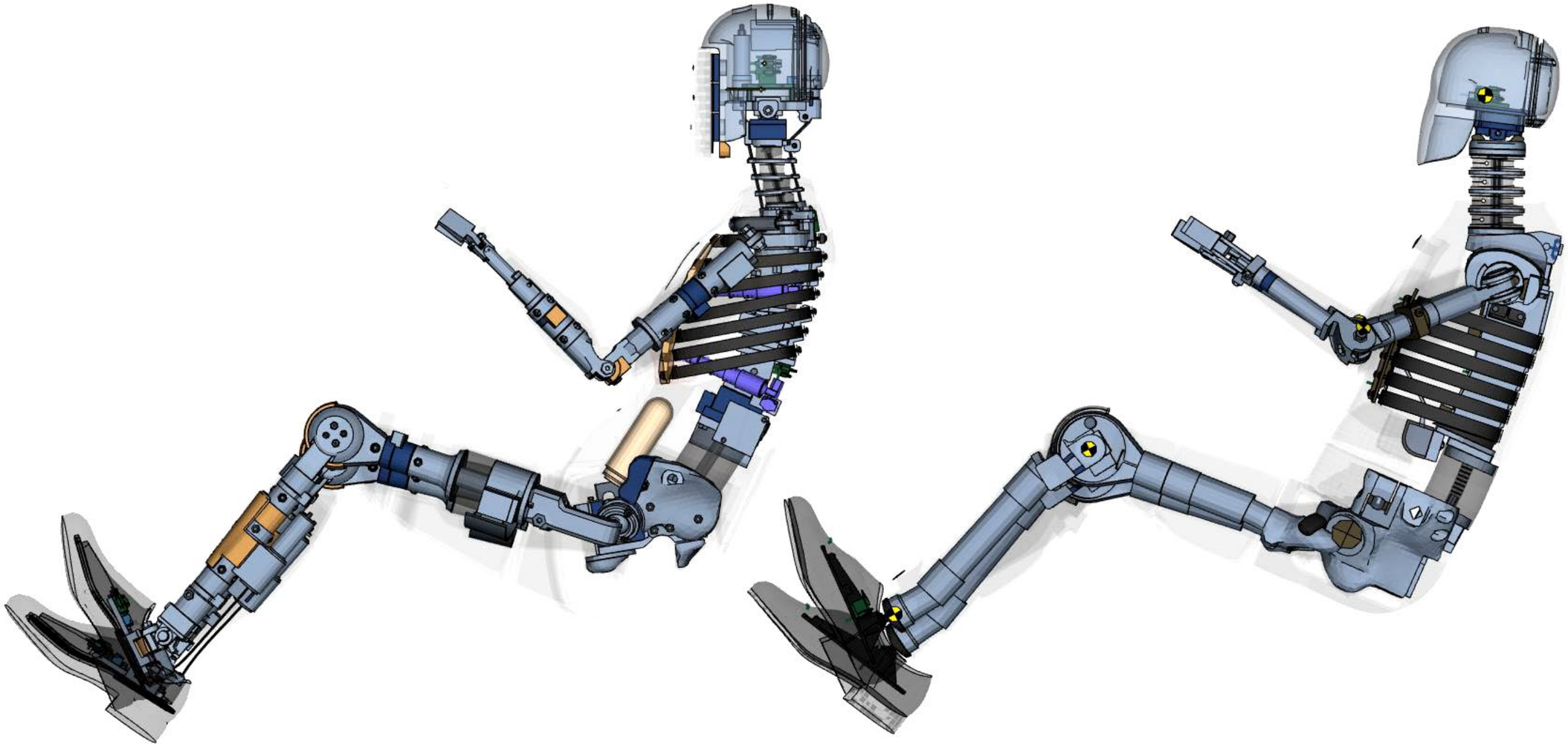
# THOR-5F vs. HIII-5F



# THE ELDERLY FEMALE

## BMI 29 Female

- The Elderly ATD represents a 70-year-old elderly female occupant with a height of 161 cm and a BMI of 29. The anthropometry of the Elderly ATD was developed in part by utilizing actual crash injury research from the International Center for Automotive Medicine (ICAM) and the University of Michigan Transportation Research Institute (UMTRI).

- The Elderly ATD features an external body shape designed in cooperation with UMTRI, precise internal organ positioning aided by the use of MRI scan data provided by ICAM, and a revolutionary new organ impact measurement system designed exclusively by Humanetics.

| | | |
|---|---|---|
| TOTAL WEIGHT | 73 kg | 160 lbs |
| STANDING HEIGHT | 161 cm | 63.4 in |

# THOR-AV 5F

## Autonomous Vehicle 5% Female

- Our cutting-edge THOR-AV 5F is an enhanced version of the THOR 5th Female dummy, featuring a refined design that better represents the female form in a crash scenario – either in a traditional vehicle seat or in an autonomous vehicle seating environment. This new dummy also offers upgraded instrumentation to allow improved data collection.

- THOR-AV-5F development started in 2019. Evaluations by NHTSA and NCAP organizations have already taken place and will continue to be carried out. The prototype dummies are available for sale, lease and rent.

| | | |
|---|---|---|
| TOTAL WEIGHT | 47.3 kg | 104.3 lb |
| SEATED HEIGHT | 788 mm | 31 in |



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# WORLDSID-5F

## Advanced Side Impact 5% Female

- The WorldSID (Worldwide Harmonized Side Impact Dummy) is an advanced ATD that was conceptualized and designed in collaboration with industry and government experts working towards a common goal – to mirror human responses in side impact scenarios.
- The WorldSID-5F was brought about by the Economic Commission for Europe (ECE) with the goal of offering enhanced evaluation capabilities for side impacts. Developed under the Advanced Protective Systems (APROSYS) integrated project, the WorldSID-5F is a scaled-down version of the WorldSID-50M.

| | | |
|---|---|---|
| TOTAL WEIGHT | 49.2 kg | 108.5 lb |
| SEATED HEIGHT | 760.9 mm | 30 in |



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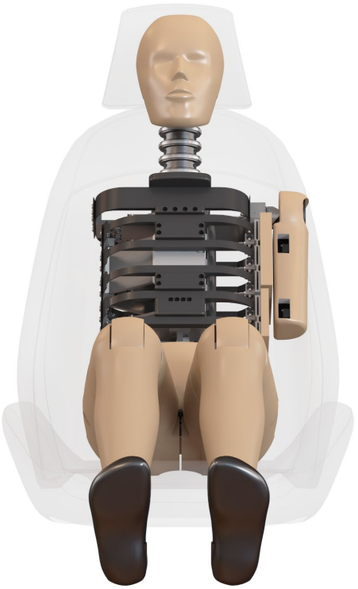
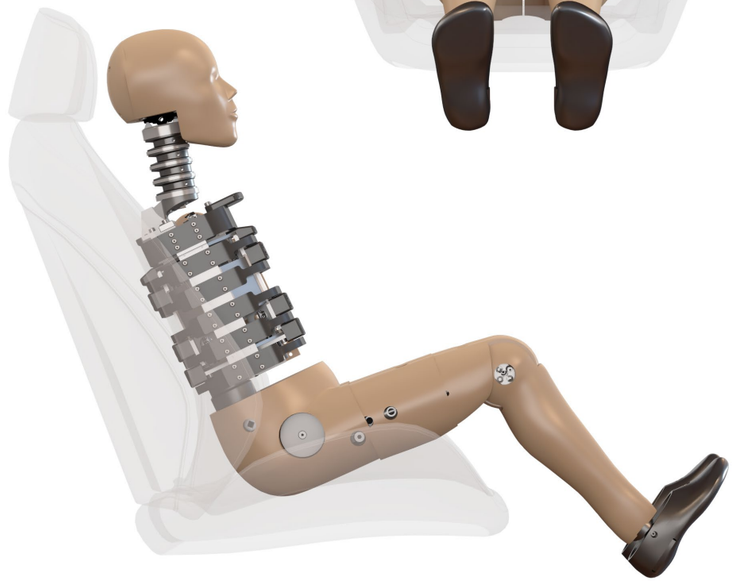
# SID-IIS

## Side Impact 5% Female

– The SID-IIs (Small Side Impact Dummy) was designed in 1994-95 to meet the needs of upgraded side impact vehicle protection – particularly side airbags. The dummy is based on our Hybrid III 5th Female ATD, but also closely matches the anthropometry of a small teenager

C-NCAP NHTSA IIHS HLDI





### Year of model: 1996

| | |
|---|---|
| DATA CHANNEL CAPABILITY | 119 |

| | | |
|---|---|---|
| TOTAL WEIGHT | 44.1 kg | 97.2 lb |
| SEATED HEIGHT | 779.8 mm | 30.7 in |



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# EvaRID

## Rear Impact 50% Female

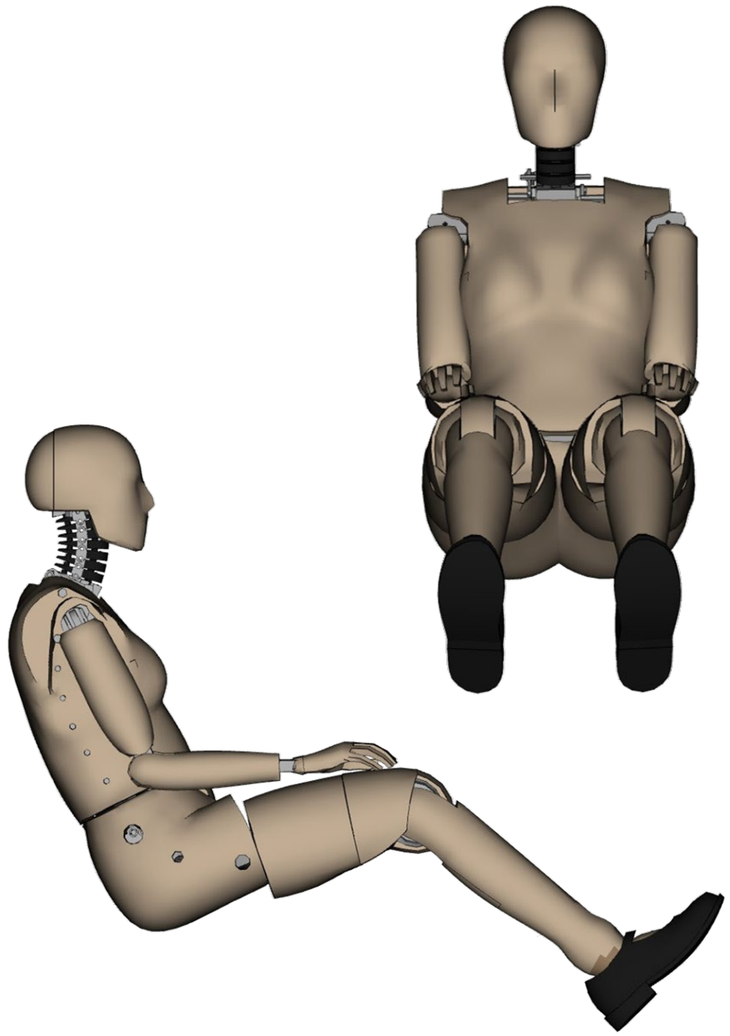
The EvaRID represents a 50th percentile female and is based on scaling data of the BioRID-II. Mass and geometrical dimensions were scaled to represent a 50th percentile female. Stiffness and damping properties of materials and discrete elements were kept in accordance with the BioRID II model. This study is part of the ADSEAT project, European Commission, ID 233904.

Research has found that women move differently in impact situations Women accelerate faster than men under impact conditions because car seat backs do not yield as much for women as they do for men, meaning that women rebound with more momentum. [1]

The EvaRID model was evaluated using rear impact tests with female volunteers.

### Year of model: 2012

| | | |
|---|---|---|
| TOTAL WEIGHT | 62.9 kg | 138.7 lb |
| SEATED HEIGHT | 806 mm | 31.7 in |



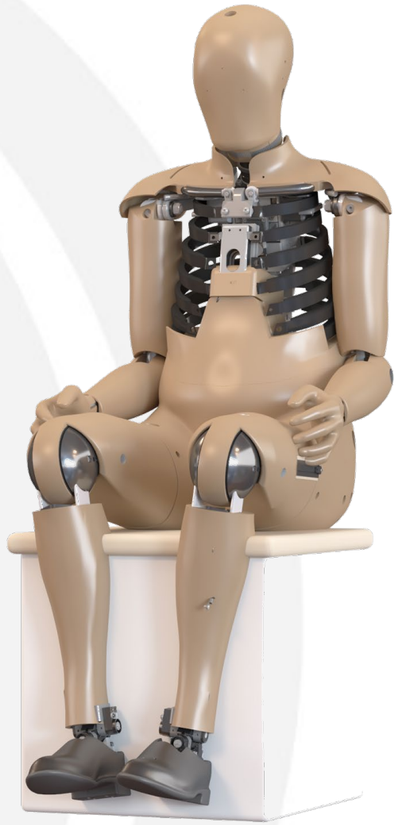
[1] https://www.cnet.com/culture/world-gets-first-female-crash-test-dummy/

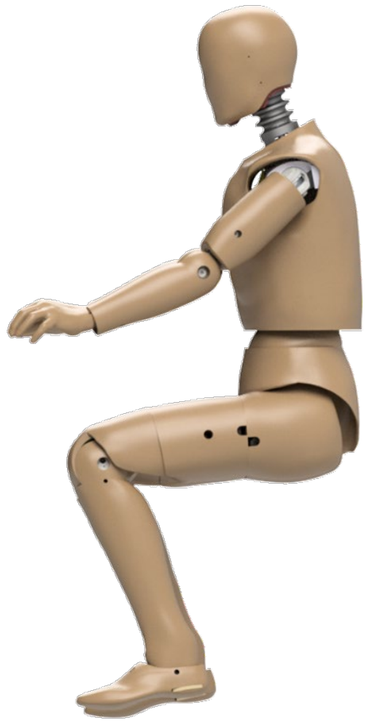
# VULNERABLE ATDS

In addition to the core test population, represented by the 50th percentile (average) male and the 5th percentile (average) female dummies, vehicle engineers are increasingly seeking to understand crash impact and injury risks for other demographic cohorts. The physiology and particular vulnerabilities of adults who are overweight, taller, or elderly differ from the core population in ways that place them at special risk of injury.

Our lineup of Vulnerable ATDs.

- Elderly Female
- Obese Male
- HIII 95$^{th}$
- PTW





# NEXT GENERATION ATDs

REPRESENTING HUMANS OF ALL SIZES, AGES, AND GENDERS

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# ABOUT US

**Humanetics** is the global leader in the design, manufacture and supply of biofidelic crash test dummies, calibration equipment, crash sensors instrumentation, software modeling and active safety testing equipment. Its devices and simulation software is used to develop safety systems in vehicles, aviation, and space rockets. In the automotive sector, Humanetics serves 100% of the OEMs and Tier I safety suppliers worldwide.

humaneticsatd.com